

FABRICATION, CHARACTERIZATION AND OPTIMIZATION
OF IN-HOUSE MOSFET TRANSISTOR USING SPIN ON
DOPANT TECHNIQUE

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JUDUL: FABRICATION, CHARACTERIZATION, AND OPTIMIZATION OF
IN-HOUSE MOSFET TRANSISTOR USING SPIN ON DOPANT TECHNIQUE

SESI PENGAJIAN: 2004/2005

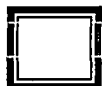
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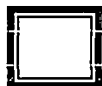
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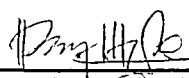
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
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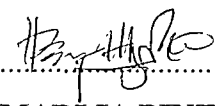
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This thesis is submitted in partial to fulfillment of the requirement for the
Master of Electrical Engineering

Faculty of Electrical and Electronic Engineering
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NOVEMBER, 2004

“Hereby, I declare that this thesis entitled “Fabrication, Characterization, and Optimization of In-House MOSFET Transistor using Spin - On Dopant Technique” is a result of my own research and idea except for the work that has been clearly cited in the references”.

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*To Mak and Ayah; for your love and support
My bros and sis, together we fight and reach the top
And for me...one step closer to hit*

ABSTRACT

This thesis explains the development and fabrication of first in-house MOSFET device using spin –on dopant technique at KUKUM Microfabrication Cleanroom. The process started with the establishment of process flow, process modules, and process parameters. Four modules were developed. The characteristics prior to the MOSFET device fabrication namely dry and wet oxidation, etching, resist thickness, exposure dose optimization, n-type and p-type spin on dopant and diffusion and also metal thickness characterization were recorded. The data were analyzed and applied in the fabrication of MOSFET devices. The MOSFET fabrication process used blanket-field oxide for isolation, positive resist for lithography process, Boron and Phosphorus for source/drain doping and aluminum for metallization. The whole MOSFET process had four masking process specifically source/drain masking, gate masking, contact masking, and metal masking. The result for each processes are presented in this thesis.

ABSTRAK

Tesis ini menerangkan mengenai pembangunan modul dan proses fabrikasi peranti MOSFET yang pertama dibina menggunakan teknik “spin –on dopant” di Bilik Bersih, Makmal Mikrofabrikasi, KUKUM. Proses ini bermula dengan membangunkan aliran proses fabrikasi, modul proses and mengenalpasti paramater- parameter yang terlibat. Empat modul telah dibangunkan sebelum proses fabrikasi peranti MOSFET iaitu pengoksidaan basah dan kering serta punaran, ketebalan rintang foto dan pengoptimuman dos dedahan, resapan jenis n dan jenis p serta penglogaman. Setiap data dianalisa dan hasilnya digunakan di dalam proses fabrikasi MOSFET. Proses fabrikasi MOSFET menggunakan pengoksidaan selimut - medan untuk pengasingan transistor, rintang foto positif bagi proses lithografi, boron dan fosforan sebagai dopan untuk proses resapan dan aluminium bagi proses penglogaman. Keseluruhan proses ini melibatkan empat jenis topeng ; topeng telaga (salir dan sumber), topeng get, topeng tingkap sentuhan dan topeng logam. Hasil bagi setiap proses dinyatakan di dalam tesis ini.

ACKNOWLEDGEMENT

First of all, I would like to thank my project supervisors, Prof. Dr. Hashim bin Saim and Ass. Prof. Dr. Uda bin Hashim for providing me guidance and dedications to carry out this project.

I would like to express my sincere gratitude to Nurhamidah, Teaching Engineer and all staffs at School of Microelectronic Engineering, KUKUM and not forgotten to all staffs at Pusat Pengajian Siswazah, KUiTTHO for their valuable contribution and help.

Lastly, to all my beloved friends who were involved in this project whether directly or indirectly. Special thanks for all of you.

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LIST OF SYMBOL

a	Lattice parameter
A	Constant in oxidation law
\AA	Symbol for 10^{-10}cm or 10^{-8}m
B	Constant in oxidation law
β	Linear gain
C	Capacitance per unit area
C_{ox}	Oxide capacitance per unit area
D	A dopant (chemical equation only)
D	Diffusion coefficient
g_m	Transconductance
h	Planck's constant
I	Current
I_B	Body current
I_D	Drain current
I_G	Gate current
I_S	Source current
j	Flux
k	Boltzmann's constant
k	Segregation coefficient
l	A length
m	Mass
MOSFET	Metal Oxide Semiconductor Field Effect Transistor

NMOS	N- Channel Metal Oxide Semiconductor
PMOS	P- Channel Metal Oxide Semiconductor
q	Charge on the electron
Q	Charge per unit area
t	Time
t_{ox}	Oxide thickness
V_B	Body voltage
V_D	Drain voltage
V_{DS}	Drain – Source Voltage
V_G	Gate voltage
V_{GS}	Gate-Source Voltage
V_{TH}	Threshold voltage
W	Work function of metal
x_i	Initial oxide thickness
x_j	Junction depth
x_o	Thickness of oxide film
X	Property of material
ϵ	Permittivity
ϵ_o	Permittivity of free space
ϵ_{ox}	Permittivity of silicon dioxide
μ	Mobility
μ_n	Electron mobility
μ_p	Hole mobility
ρ	Charge distribution
ρ	Resistivity
ρ_s	Sheet resistivity
R_s	Sheet resistance
Ω	Symbol for ohms

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CHAPTER I

PROJECT OVERVIEW

1.1 Overview

This chapter will explain the project overview including objective, scopes, and methodology of project.

1.2 Introduction

The rise of MOS technology is a classic study since it is the most important devices in electronic industry [1] due to its capability. This project is stressed on the fabrication, characterization, and optimization of in-house MOSFET devices. In order to fabricate the devices, the process module development was established and formed backbone of this project.